# Q1 - Current Uses

- Energy Trading
  - Forecasted energy production for Utility PV plants
  - Forecasts 15 minute to 5 days out
- Distribution System Operator
  - Energy production for FIT and DG systems
  - Generation visible at field transformer and Substation
- Resource Planning
  - Long term system planning studies

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# Q1- Current Limitations

- Energy Trading
  - Need for more accurate distributed generation forecasts
  - Solar variability and reserves
- Distribution System Operators
  - Connect solar forecasts to distribution management system
- Resource Planning
  - Variability is not correctly identified at sub 5 minutes ramps

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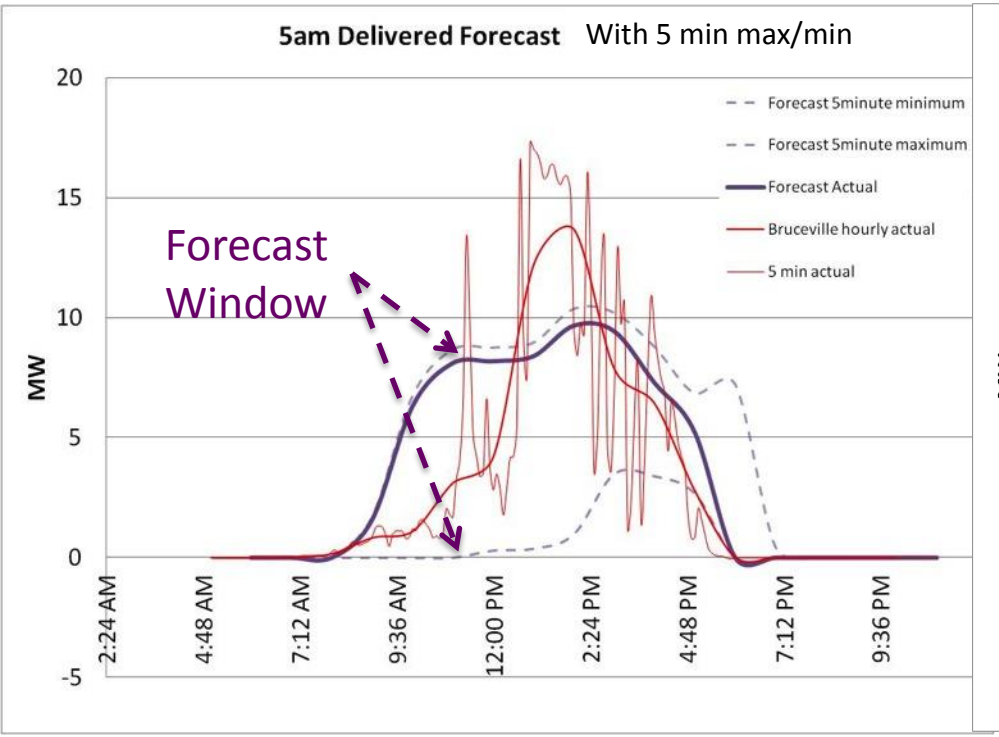
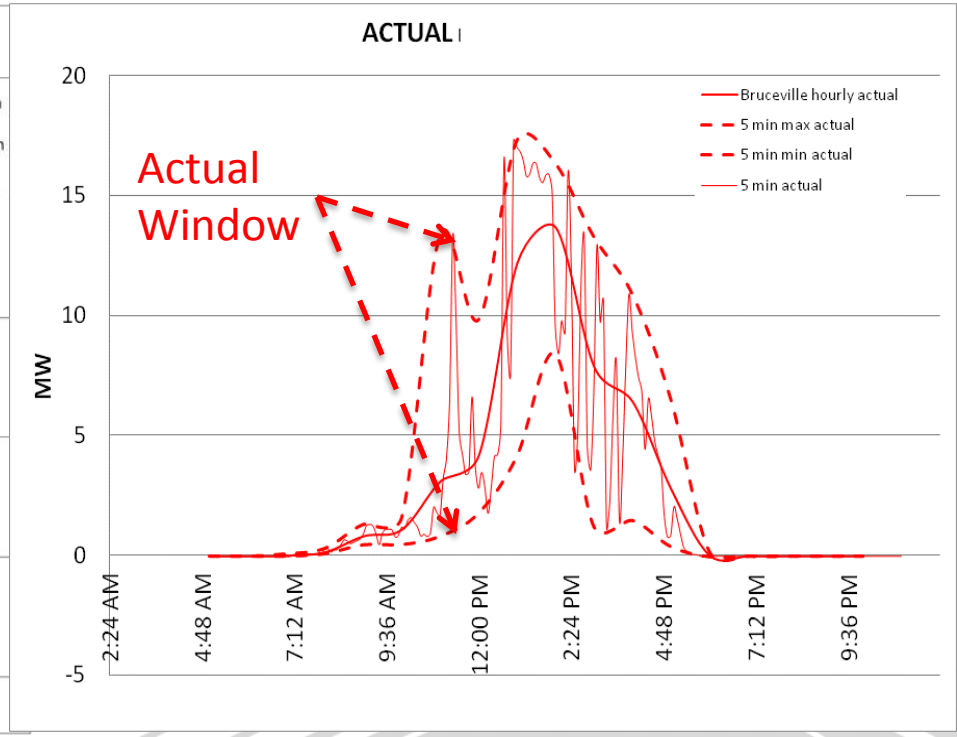
# Q2 - Probablistic Forecasts

(Provide 5 minute average max and min values for a given hour)

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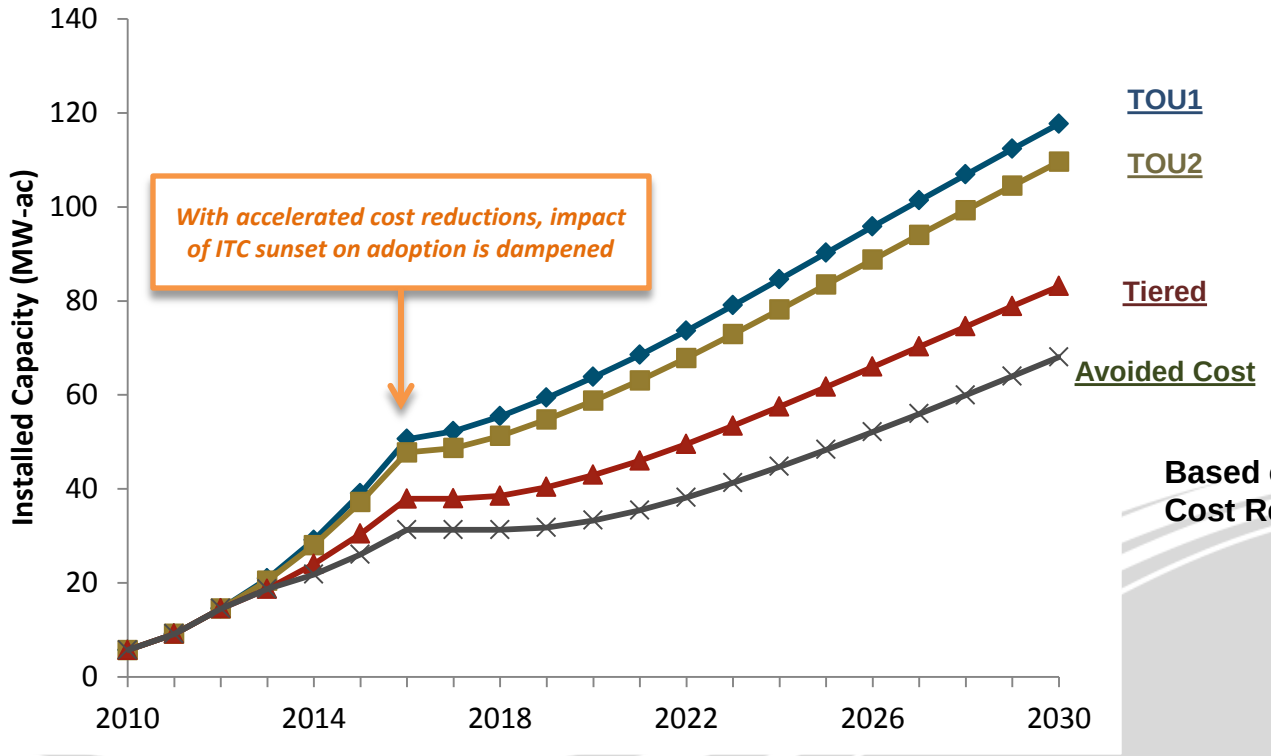
# Q3 - Residential Market Analysis

- Residential installed capacity in 2030 ranges from 60-115 MW-ac




**Based on Accelerated PV Cost Reductions**

*From E3 report presentation "SMUD Distributed PV Forecast Development", April 11, 2014*

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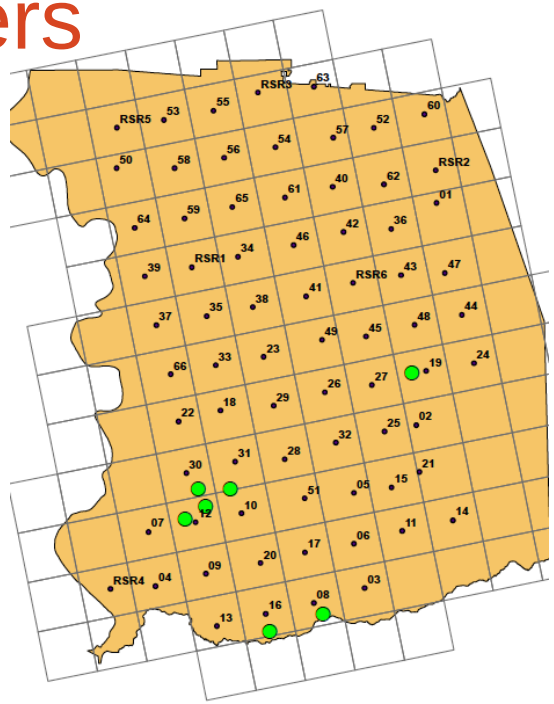
# Q4 - Overview of Solar Monitoring Network, Data, and Forecasters

- Contracted with 4 commercial forecasters (Clean Power Research, Garrad Hassan, Green Power Labs, and AWSTruePower) to provide detailed forecasts of irradiance and power
- Forecasting trial was conducted from August 2012 to Dec 2013
- Forecasts were for 8 PV sites (~100MW) 74 distributed irradiance (66GHI, 8GHI/DNI) measurement sites (5 km spacing)
- Forecasts were hour ahead out to 5 days, 80% confidence interval, 5 minute max and min values (473 Million Data Points for 1 year)
- 1 year of forecast data was analyzed for 3 forecasts and 6 months for 1.
- Significant analysis done by Sandia National Labs




2,200 sqkm
74 irradiance sites
8 utility PV sites
150MW PV
3300 MW Peak
900 MW daytime min

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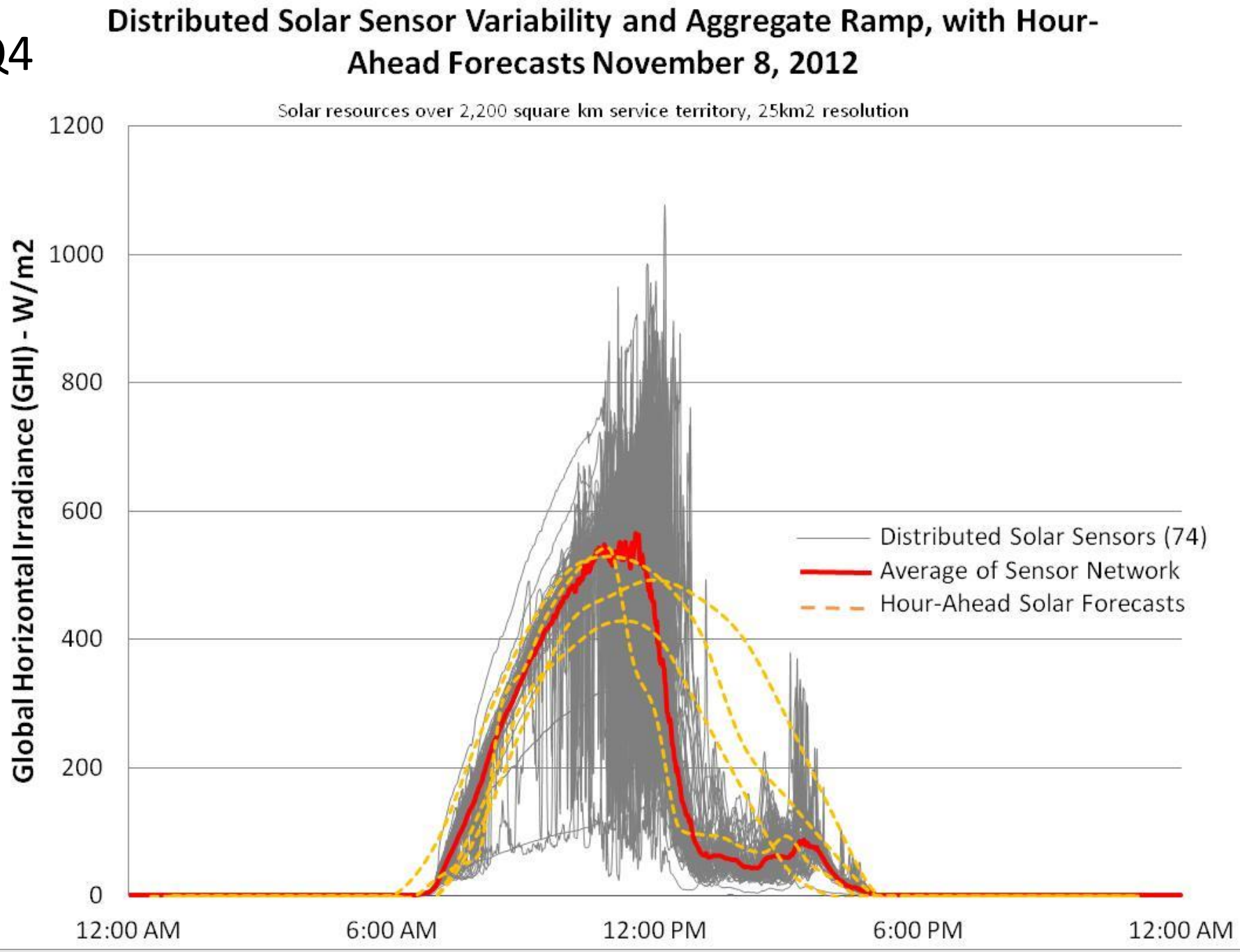
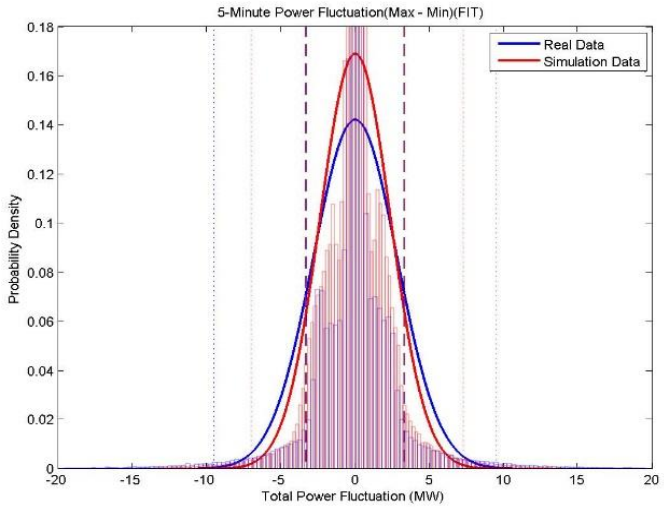
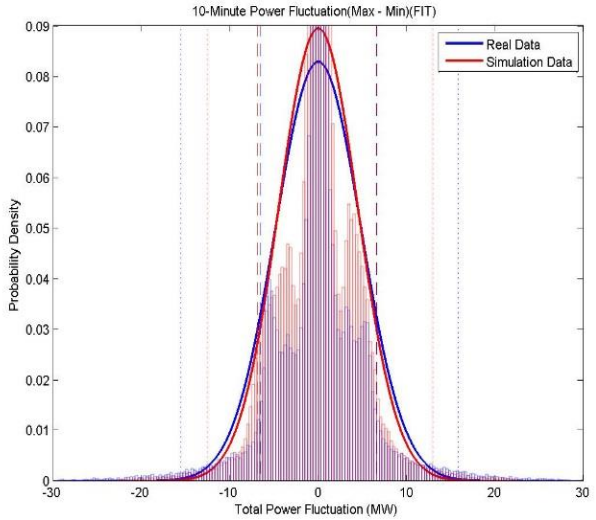
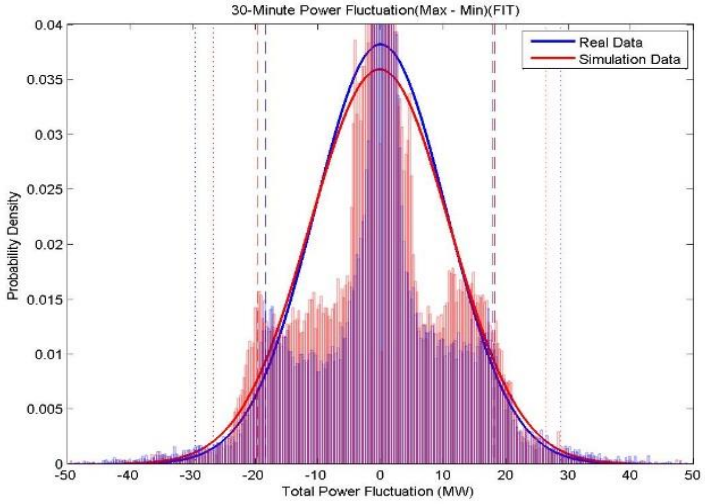
Q4

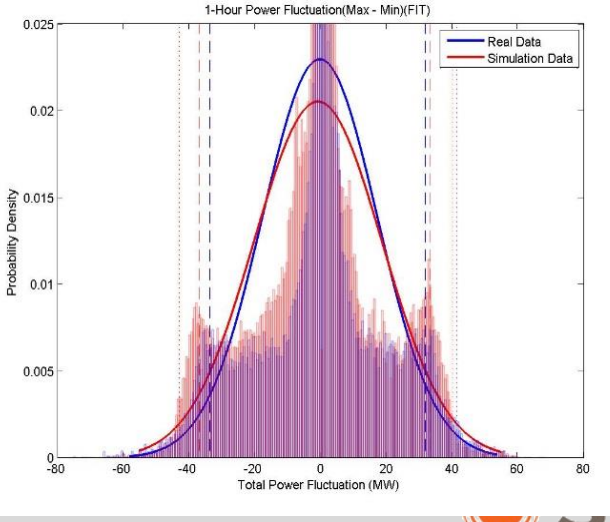

Distributed Solar Sensor Variability and Aggregate Ramp, with Hour-Ahead Forecasts November 8, 2012
Solar resources over 2,200 square km service territory, 25km2 resolution
Global Horizontal Irradiance (GHI) - W/m2
1200
1000
800
600
400
200
0
12:00 AM
6:00 AM
12:00 PM
6:00 PM
12:00 AM
Distributed Solar Sensors (74)
Average of Sensor Network
Hour-Ahead Solar Forecasts

# Q4 - Simulated Data Validation



# Q8 - Motivation For Distributed PV Forecasting

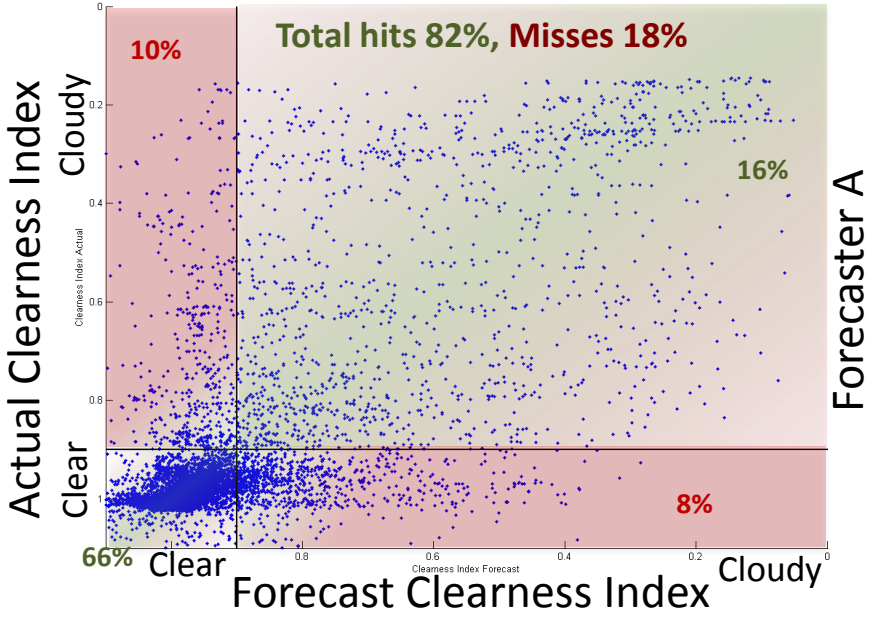
- Change
  - Distributed PV is rapidly growing
  - Fundamental problem: Lack of visibility into the loading of each section on the system.

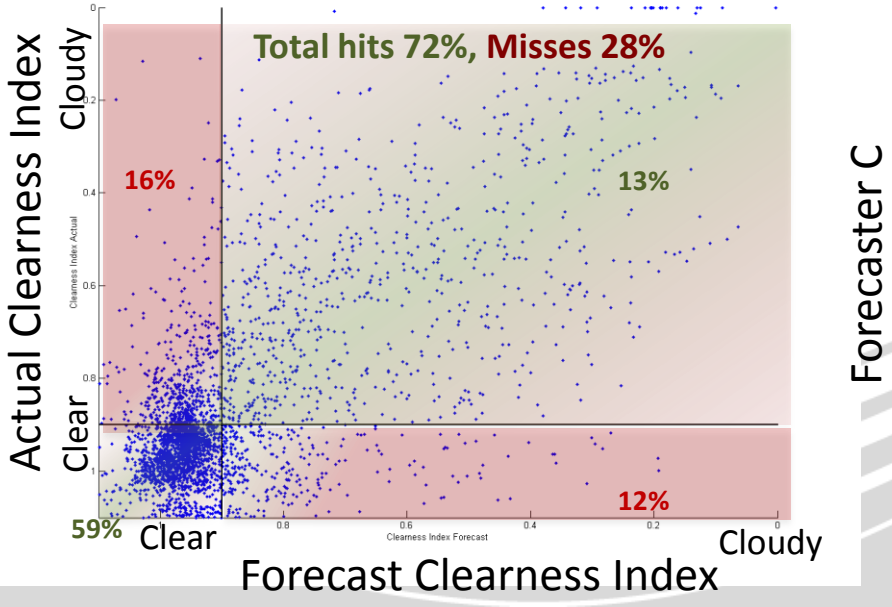
    -Operators can only “see” the net load on the circuit from SCADA and net meters

    -Operators want to be able to also see and predict the “native” load and the PV generation
- Opportunity
  - Advances in Management Systems allow the opportunity to leverage smart inverter functionality and data.
  - Distributed PV forecasts can help optimize and dispatch smart inverters

# Q8 - Clear Sky Prediction Threshold (DA Forecasts)

ıged irradiance values, daily CI binning




- Energy Traders set CI of 0.9 threshold for scheduling regulation reserves
- Forecasts below CI 0.9 resulted in regulating reserves scheduled for difference between expected value and max/min value for that month
- Forecast misses easily identified under this ‘contingency table’ type of approach

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